Title of the Invention

Golf Club Head

Background of the invention

Field of the Invention

The present invention relates to a golf club head having a structure being capable of increasing the degree of freedom of design and the degree of freedom of selecting materials.

Description of the Related Art including information disclosed under 37 CFR 1.97-1.99

Conventionally, wood-shaped metallic golf club heads are formed by welding metallic parts together. Such club heads are disclosed in the following prior arts.

In United States Patent 5,024,437 (Patent date: 18 June 1991, Filing date: 13 March 1990), a golf club head having a two-piece structure is disclosed, wherein the two pieces are a face plate and a main body. The face plate is fabricated of forged carbon steel, forged stainless steel, forged berylium copper or forged titanium. The main body is formed by investment casting of stainless steel, beryllium copper, titanium, aluminum or the like.

In Japanese patent No. 3135396 (Issue date: 1 December 2000, Laid-open date: 21 June 1994, Filing date: 4 December 1992), a golf club head having a two-piece structure is disclosed. In this case, the head is hollow, and the two pieces are a face plate and a main body. The main body is formed by casting of a titanium alloy. The face plate is fabricated of rolled or forged titanium alloy which is different from the titanium alloy of the main body.

In the laid-open Japanese patent application JP-A-3-51065 (Laid-open date: 5 March 1991, Filing date: 19 July 1989), a golf club head having a two-piece structure is disclosed. In this case,

the head is also hollow, and the two pieces are a bottom-opened main body and a sole plate closing the bottom. The main body is formed by casting of titanium or a titanium alloy. The sole plate is fabricated of pressed titanium or a pressed titanium alloy.

In general, castings have a tendency to decrease the strength sharply when the thickness is decreased beyond a certain value due to crystal structure and material imperfection such as air holes. Thus, it is necessary to design the thickness somewhat greater.

In the hollow club heads as in the later two prior arts, therefore, it is difficult to decrease the thickness of the crown for the purpose of lowering the center of gravity, and decrease the thickness of the face for the purpose of improving the restitution coefficient. Further, it is difficult to optimize the position of the center of gravity, weight distribution, moment of inertia and the like of the head. Thus, the freedom of designing the head is considerably limited.

Summary of the Invention

It is therefore, an object of the present invention to provide a golf club head, in which the degree of design freedom is increased, and the position of the center of gravity, moment of inertia and the like of the club head can be optimized.

According to the present invention, a golf club head comprises a face for hitting a golf ball, a crown, a sole, a sidewall extending from the periphery of the sole towards the crown excluding the face, and a neck to be fixed to a shaft, and the golf club head is formed by welding together a face member for forming the face, a crown member for forming the crown and a walled sole member for forming at least the sole and the sidewall,

wherein the walled sole member is made by casting, and the face member and the crown member are each made by plastic deformation processing.

Brief Description of the Drawings

Fig.1 is a perspective view of a golf club head according to the present invention.

Fig.2 is a cross sectional view thereof.

Fig.3 is an exploded view of the head showing a four-piece structure.

Fig.4 is an exploded view of the head showing a three-piece structure.

Description of the Preferred Embodiments

Embodiments of the present invention will now be described in detail in conjunction with the accompanying drawings.

In the drawings, golf club head 1 according to the present invention is a wood-shaped metallic head for a metal wood club.

As shown in Fig.1, the golf club head 1 is hollow and has a face 2 for hitting a golf ball, a crown 3 defining an upper face of the head intersecting the face 2 along the upper edge 2a of the face 2, a sole 4 defining a bottom face of the head intersecting the face 2 along the lower edge 2b of the face 2, a sidewall 5 between the crown 3 and sole 4 extending between the toe side edge and heel side edge of the face 2 through the back of the head, and a neck 6 to be fixed to a shaft (not shown).

In Fig.3 showing a first embodiment, the golf club head 1 has a four-piece structure comprising a planar face member 12 for forming the face 2, a slightly curved crown member 13 for forming the crown 3, a neck member 16 for forming the neck 6, and a walled sole member 17 which is composed of a sole part 14 for forming the

sole 4 and a sidewall part 15 for forming the sidewall 5, extending upwards from the periphery 14e of the sole part 14 excluding the face 2. These members 12, 13, 16 and 17 are welded together.

The walled sole member 17 is made by casting. In other words, the sole part 14 and sidewall part 15 are formed as a monoblock casting 20. Contrary, the face member 12 and crown member 13 are made by plastic deformation processing. In other words, each of the face member 12 and crown member 13 is a plasticity processed piece 21.

Here, the term "plastic deformation processing" means various processing methods being made utilizing plastic deformation to achieve the final shape of the part, inclusive of forging and press forming. The forging includes "cold forging" at room temperature, "warm forging" at an under recrystallization temperature and "hot forging" at an over recrystallization temperature, which may be made using a die, hammer, press or the like. The press forming includes "bending" and "drawing" being made utilizing a press. The processing temperature thereof is not limited here.

As for the casting, on the other hand, it is also possible to employ various methods, but "precision casting" is preferable.

In this example, a "lost-wax precision casting" is employed in making the above-mentioned walled sole member 17 to provide a variable thickness distribution for the sole part 14 and the sidewall part 15 in order to realize an optimum weight distribution.

As for the material of the walled sole member 17, a titanium alloy such as Ti-6Al-4V having a low specific gravity and

high strength may be preferably used.

The thickness ratio (t2/t1) between the minimum thickness t1 and maximum thickness t2 of the walled sole member 17 is set in a range of from 1.2 to 3.0, preferably 1.5 to 2.5.
For example, the minimum thickness t1 and maximum thickness t2 of the walled sole member 17 are 0.8 mm and 3.5 mm, respectively.

Because the walled sole member 17 which forms the major part of the head is a monoblock casting, it is easy to change the thickness in the sole part 14 and sidewall part 15. Accordingly, a desired weight distribution can be obtained without using a separate weighting member. This increases the degree of freedom of designing the head especially the gravitational center and the moment of inertia.

The face member 12 and crown member 13 in this example are made as follow. A material for each member 12, 13 is punched out in a specific shape (as shown in Fig.3) from a rolled sheet metal having a substantially uniform thickness. Then, the material is bent by a press.

For example, the thickness of the face member 12 is in a range of from 2.0 to 3.5 mm, preferably 2.0 to 3.0 mm. If the thickness is less than 2.0 mm, the durability and strength thereof are liable to become insufficient. If the thickness is more than 3.5 mm, the restitution coefficient is liable to decrease and the weight distribution is liable to become not good.

The crown member 13 has a substantially constant thickness of from 0.7 to 1.2 mm, preferably 0.7 to 0.9 mm. If the thickness is less than 0.7 mm, the strength becomes insufficient. If the thickness is more than 1.2 mm, the center of gravity of the head becomes high and the golf club is liable to become difficult to

handle.

Because the face member 12 and crown member 13 are made by plastic deformation processing, the degree of freedom of selecting the metallic material increases when compared with casting. For example, a titanium alloy Ti-15V-3Al-3Sn-3Cr whose tensile strength is higher than Ti-6Al-4V, can be used although it is not suitable for casting. In this example, such titanium alloy plate is used. Therefore, the thickness of the face member 12 can be decreased to the above-mentioned range without difficulty, thereby improving the restitution coefficient.

The rolled sheet metal has a minute crystalline structure, and its material imperfection such as air holes which are often found in castings is very rare. Accordingly, the rolled sheet metal has a high strength evenly. Therefore, the head can be decreased in the thickness in the face 2 and crown 3, while maintaining a sufficient strength. This also helps to reduce the weight of the head. Further, due to the substantially constant thickness of the face member 12 and crown member 13, accurate positioning of the center of gravity becomes easy in designing the head.

In this embodiment, the above-mentioned neck member 16 is made by forging. But it may be made by pressing, casting, cutting, miling or the like.

Fig.4 shows a golf club head 1 according to the present invention which has a three-piece structure.

In this embodiment, the above-mentioned neck member 16 and walled sole member 17 are formed as a monoblock casting (hereinafter the "member 22").

Thus, the member 22 comprises a sole part 14 for forming

the sole 4, a sidewall part 15 for forming the sidewall 5, and a neck part 16 forming the neck 6. Accordingly, the golf club head 1 is composed of the member 22, a face member 12 and a crown member 13 which are welded together.

The face member 12 and crown member 13 have been described in the former embodiment. Although the member 22 is made by casting, the face member 12 and crown member 13 are made by plastic deformation processing as explained above. The above description of the walled sole member 17 may be applied to the member 22.

In this embodiment, as the sole part 14, sidewall part 15 and neck part 16 are formed as a monoblock casting, it is easy to improve the accuracy of the neck 6 in respect of its dimension and angle relative to the sole 4 when compared with the separate neck member 16.

In both the embodiments shown in Fig.3 and Fig.4, the assembly, namely, the head 1 has the following specifications.

The volume of the head 1 is set in a range of not less than 250 cm^3, preferably not less than 280 cm^3, more preferably not less than 300 cm^3.

The sweet spot height H is set in a range of not more than 28.0 mm.

The depth L of the center of gravity G is set in a range of not less than 36.0 mm.

The lateral moment of inertia of the head is set in a range of not less than 3500 cm^4, and the vertical moment of inertia is set in a range of not less than 2000 cm^4.

Definition

Sweet spot: The sweet spot SS is defined as a point at

which a straight line N drawn normally to the face from the center of gravity G intersects the face.

Standard state: A state that the head is set on a horizontal plane satisfying its lie angle and loft angle.

Sweet spot height H: A vertical height measured from the horizontal plane to the sweet spot SS in the standard state.

Depth L of the center of gravity: The horizontal distance between the center of gravity G and the leading edge E of the head measured in the standard state.

Moment of inertia: The lateral moment of inertia is the moment of inertia around the vertical axis passing through the center of gravity G in the standard state. The vertical moment of inertia is the moment of inertia around a horizontal axis passing through the center of gravity G in the toe-heel direction of the head in the standard state. These moments were measured with "Moment of Inertia Measuring Instrument MODEL NO.005-002, INERTIA DYNAMICS Inc."

As for the metallic material of each of the members 12, 13, 16, 17 and 22, it is preferable that the specific gravity thereof is not more than 5.0. If the specific gravity is more than 5.0, due to weight constraint, it is necessary to decrease the thickness of the material, restricting the rigidity and strength, and requirements for dimensional accuracy will be more strict. For example, titanium alloys, pure titanium, aluminum alloys, magnesium alloys and the like are preferably used.

The members 12, 13, 16 and 17 may be of the same material. But, preferably, different materials are used at least between the face member 12 and the other member (17, 22)

Comparison Tests

Wood-shaped golf club heads having the same outward form were made by way of test and tested as follows. The results are shown in Table 1.

Restitution coefficient test: The restitution coefficient e was measured according to the "Procedure for Measuring the Velocity Ratio of a Club Head for Conformance to Rule 4-1e, Appendix II, Revision 2 (February 8, 1999), United States Golf Association." The distance between the face of the club head and the launching device to produce a ball velocity of 160+/-0.5 fps was 55 inches. The radius of the target circle on the face was 5 mm. The golf balls used were "Titleist, PINNACLE GOLD."
In Table 1, "A" means the restitution coefficient e is not less than 0.81. "B" means the restitution coefficient e is less than 0.81.

Hook angle deviation test: The hook angle of the face was measured, and the deviation of the measured angle from the design angle was examined. In Table 1, "A" means good. "B" means not good.

Table 1

		Ex.1	Ex.2	Ref.1	Ref.2	Ref.3
Head volume (cm^3)		320				
Head weight (g)		186				
Making method and Material	Head structure	Fig.2	Fig.3	Fig.3	Fig.6	--
	Face member	press forming 2.8 mm thick Ti-15V-3Al-3Sn-3Cr	press forming 2.8 mm thick Ti-15V-3Al-3Sn-3Cr	casting 3.0 mm thick Ti-6AL-4V	press forming 2.8 mm thick Ti-15V-3Al-3Sn-3Cr	press forming 2.8 mm thick Ti-15V-3Al-3Sn-3Cr
	Crown member	press forming 0.8 mm thick Ti-15V-3Al-3Sn-3Cr	press forming 0.8 mm thick Ti-15V-3Al-3Sn-3Cr	casting 0.9 mm thick Ti-6AL-4V	press forming 0.8 mm thick Ti-15V-3Al-3Sn-3Cr	casting Ti-6AL-4V thickness crown part 0.9 mm sole part 1.2 to 2.0mm wall part 1.2 to 2.0mm
	Sole part Wall part	casting 1.2 to 2.0mm thick Ti-6AL-4V	casting 1.2 to 2.0 mm thick Ti-6AL-4V	casting 1.2 to 2.0 mm thick Ti-6AL-4V	press forming 1.2 mm thick Ti-6AL-4V	
	Neck part (Outer diameter=12 mm)	forging Pure Ti			press forming Pure Ti	
Sweet spot height (mm)		28.0	27.9	28.7	29.0	28.4
Depth of Center of gravity (mm)		37.1	36.8	35.4	34.3	35.9
Lateral moment of inertia (cm^4)		3540	3535	3512	3350	3446
Vertical moment of inertia (cm^4)		2060	2055	1946	1968	2035
Restitution coefficient		A	A	B	A	A
Hook angle deviation		B	A	A	B	A

In the club heads according to the invention, it was possible to set the sweet spot lower and the center of gravity deeper. It was also possible to set the moment of inertia larger. As the sweet spot height becomes lower, the flying distance may be increased because an excessive backspin is avoided.

As the center of gravity G becomes deeper, the sweet area becomes broader, and a loss of the flying distance at the time of miss shot can be minimized.

As the moment of inertia becomes larger, the head becomes stable even when missed, and a loss of the flying distance can be decreased.